NOTICE

All drawings located at the end of the document.

RF/ER-95-0005

EG&G

ROCKY FLATS

Final Technical Memorandum No. 5
Revised Soil Gas Sampling Plan
Original Landfill
Operable Unit No.5

Rocky Flats Environmental Restoration Project

February 1993

FINAL
TECHNICAL MEMORANDUM NO. 5

ADDENDUM TO FINAL PHASE I
RFI/RI WORK PLAN

Revised Soil Gas Sampling Plan -- Original Landfill

Rocky Flats Plant
Woman Creek Priority Drainage

(Operable Unit No. 5)

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Prepared for:

U.S. DEPARTMENT OF ENERGY
Rocky Flats Plant
Golden, Colorado

February 1993

RFI/RI WORK PLAN TECHNICAL MEMORANDUM
APPROVAL SHEET

EG&G ROCKY FLATS PLANT	Document Number:	RF/ER-95-0005
	Section: (Sect. #) (Rev. #)	Approval Sheet
	Page:	1 of 1
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TITLE:

Operable Unit No. 5, Technical Memorandum No. 5
Addendum to Final Phase I, RFI/RI Work Plan
Revised Soil Gas Sampling Plan - Original Landfill
Rocky Flats Plant
Worman Creek Priority Drainage

Approved By:

OU5,6&7 Closures Program Manager — Date: 8/4/94

OU5 Project Manager — Date: 8/16/94

ER QA Program Manager — Date: 9/1/94

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Approved By:

n/a
Name (Date)

FINAL TECHNICAL MEMORANDUM
IHSS 115 (ORIGINAL LANDFILL) SOIL GAS SURVEY

1.0. INTRODUCTION

1.1 BACKGROUND

A real-time soil gas survey is proposed as part of the Phase I RCRA Facility Investigation/Remedial Investigation (RFI/RI) field investigations to identify areas of volatile organic contamination within Individual Hazardous Substance Site (IHSS) 115 (the Original Landfill and the disturbed area located to the east of the Landfill) of Operable Unit (OU) 5 (Woman Creek Priority Drainage) of the Rocky Flats Plant (RFP). The Original Landfill is located within the buffer zone just south of the Rocky Flats Plant controlled area and south of the west access road (Figure 1). The boundary of the landfill has been determined principally from historic aerial photographs and from the operational history of this unit. The Environmental Protection Agency (EPA) and the Colorado Department of Health (CDH) have extended the southern boundary of this IHSS for the purpose of this work plan (Figure 1). The landfill and its preliminary extension are approximately 330,000 square feet (7.5 acres) (DOE, 1992).

Volatile organic chemicals that may have been placed in this landfill include commonly used solvents, such as trichloroethylene, carbon tetrachloride, tetrachloroethylene, petroleum distillates, 1,1,1-trichloroethane, dichloromethane, benzene, paint and paint thinners. Metals such as beryllium, uranium, lead, and chromium may also be present (DOE, 1992).

1.2 PURPOSE AND SCOPE

The purpose of the soil gas survey is to provide Phase I screening-level data concerning the presence or absence of volatile organic contaminants at the Original Landfill and the disturbed area east of the Old Landfill (DOE, 1992). Anomalous readings encountered during the survey will be verified by resampling. Plumes of volatile organics identified by the soil gas survey will be further assessed by the subsequent drilling of soil borings within the plumes, as specified in the OU 5 Work Plan.

This Draft Final Technical Memorandum presents the proposed soil gas sampling locations and methods. This memorandum incorporates the currently available information from the Inter-Agency Agreement (IAG), the February 1992 Phase I RFI/RI Work Plan for OU 5, results of the 1990 High-Purity Germanium (HPGe) Survey, results of the November 1992 Electromagnetic (EM) and Magnetometer Surveys (described in Section 2.0 of this Technical Memorandum), Standard Operating Procedures (SOPs) GT.9 and FO.3, and specifications supplied by the subcontractor who will be performing the soil gas survey. The locations of the soil gas sampling sites were determined as a result of the above-mentioned information.

2.0 PRELIMINARY FIELD WORK

Existing aerial photographs were examined to assess the extent of the Original Landfill and the disturbed area to ~~the east~~ (Figure 1). Data from the 1990 HPGe gamma radiation survey were also evaluated because anomalies in radioactivity (particularly cesium-137 (Cs^{137})) may be an indication of protruding waste or buried radioactive waste. Such results provide indications of the areas the soil gas survey grid should cover and also provide information on the safety aspect of surveying the area.

An electromagnetic (EM) survey was conducted September through November 1992 as part of this OU 5 RFI/RI (Figure 2). The purpose of this survey was to detect conductivity differences in disturbed soil to assess landfill boundaries. Results from this survey indicated possible locations of subsurface saline water, solvent plumes, and ferrous and other metallic objects. Such objects may be an indication of buried waste, thereby also indicating possible IHSS boundaries.

A magnetometer survey was also conducted September through November 1992, primarily to further clarify the EM data (Figure 3). The results from this survey were reviewed to locate subsurface ferrous objects. The specifications of the soil gas survey sample locations are based on the delineation of the IHSS boundaries from the results of these preliminary surveys, as specified by the OU 5 RFI/RI work plan (DOE, 1992).

Prominent surface features were located during the field work and aerial photograph review and are described below. These features may be indications of the areal extent of the Original Landfill.

2.1 AERIAL PHOTOGRAPH REVIEW

A review of the vertical aerial photographs covering the Original Landfill (IHSS 115) resulted in some modification to Figure 2-2 (IHSS 115 Original Landfill) of the OU 5 Work Plan.

Although Figure 2-2 indicated the general configuration of the Original Landfill area, it did not define several features that were constructed while the landfill was active. These features, which were subsequently buried through the continued use of the landfill, were identified on the vertical aerial photographs ~~and~~ are shown on Figures 2 and 3 of this Technical Memorandum. An outfall pipe was also constructed after the landfill was abandoned and is also shown on Figures 2 and 3.

The features that were identified on the photographs taken during the operational phase of the landfill consisted of an area possibly used as a pit, an area of disturbed ground on the west end of the landfill, a berm located on the west side and to the south of the landfill, and a drainage ditch located in the north central portion of the landfill area that was visible in the photographs from 1955 through 1983. The berm is significant in that later oblique aerial photographs disclosed that metallic debris were stacked behind the berm and later buried. Oblique aerial photographs also indicated the existence of a culvert, beneath the railroad tracks and road, that discharged into the drainage ditch. There was no evidence, in later photographs, that this culvert was removed as the ditch was covered.

The outfall pipe shown on the east side of the landfill was constructed in 1987 and the disturbed ground associated with the excavation is visible on the 1988 vertical aerial photograph. Some of the existing landfill area was disturbed as a result of this project and additional fill material was added, to the east of the existing dirt road, to construct an energy dissipation basin for the effluent from the line prior to entering the South Interceptor Ditch (SID).

2.2 GAMMA RADIATION SURVEY RESULTS

In 1990, a radiation survey was conducted over the Original Landfill (IHSS 115) using a HPGe gamma ray detection system. The base survey was conducted utilizing a 150-foot grid pattern and additional stations were added at the discretion of the operator. The results of the survey were reported in Volume II of the Phase I RFI/RI Work Plan (DOE, 1992) as indicated concentrations of potassium-40 (K^{40}), radium-226 (Ra^{226}), thorium-232 (Th^{232}), Cs^{137}, and uranium-238 (U^{238}). The indicated concentrations were reported in picoCuries per gram (pCi/g) for each of the above elements and,with the exception of U^{238}, each of the radionuclides listed above were present in amounts consistent with natural background concentrations. Elevated levels of U^{238} were detected in six locations which also exhibited substantial evidence of disturbed soil cover.

Cesium-137 is a human-made fission product deposited by fallout from worldwide nuclear testing (Eisenbud, 1973). After several conversations with the manager of the HPGe program, it was determined that the Cs^{137} survey data could be used to delineate areas where the soil cover has remained undisturbed for several decades. Fallout concentrations of Cs^{137} over a given undisturbed area are expected to be relatively consistent. Because Cs^{137} concentrations over known undisturbed areas at the landfill were identified to be consistently close to 0.4 pCi/g and values over known disturbed areas were significantly less, a value of at least 0.4 pCi/g of Cs^{137} was selected as a limit to define undisturbed areas within the survey boundaries. The resulting map is shown on Figure 2 and delineates an area of possibly undisturbed ground that was found to be consistent with the original topography of the site, as determined from the examination of aerial photographs of the area.

The U^{238} survey defined six anomalous areas where the indicated uranium concentrations exceeded 4 pCi/g (Figure 2). Three of these anomalies are located on undisturbed ground and may possibly be attributed to concentrations of airborne particulates that were derived from the operation of the incinerator that was located to the west of the area. The remaining anomalies are associated with the landfill. The "known point source" shown on Figure 2 consists of a uranium nodule encrusted in an ash material that was exposed by the slumping of a bank along the landfill. This occurrence has been documented on photographs. It is probable that the remaining anomalies will be associated with similar point sources that will lie just below or be imbedded in the landfill cover material.

2.3 ELECTROMAGNETIC (EM) SURVEY RESULTS

The purpose of the EM survey conducted September through November 1992 was to measure the changes in conductivity, which may indicate the locations of subsurface saline water, solvent plumes, and ferrous and other metallic objects. Such objects may be an indication of buried waste, thereby also indicating possible IHSS boundaries. Figure 3 is a generalized presentation of the results of this survey and the magnetometer survey.

The grid baseline for the EM and magnetometer surveys will be used for the soil gas survey and is shown on Figure 4 (however, the depiction of the baseline in Figure 4 has been extended approximately 250 feet to the west). Geophysical survey points were measured at 10-foot station intervals along north-south lines that were 25 feet apart.

The surveys were conducted over the area of the Original Landfill and the disturbed area to the east of the landfill, as determined from aerial photographs and site reconnaissance. The northern extent of the survey grid was bounded by the buffer zone chain-link fence. The survey also encompassed the area in between the southern boundary of the landfill/disturbed area and Woman Creek. No data were collected inside roped areas indicating radiologically controlled areas (RCAs). No data were collected in some areas of the SID.

The preliminary EM data were presented as both conductivity and phase maps. These maps differed very little in the overall configuration of the anomalous areas within the IHSS 115 area. Shown on Figure 3 are the areas showing the highest conductivity. These anomalies may be attributed to the higher moisture content of disturbed ground, undisturbed wetlands or saturated alluvium, differences in geological sediments (i.e., shallow bedrock), or buried conductive metallic objects. The overall results tend to indicate that the conductive anomalies shown on Figure 3 can be attributed to both naturally-occurring partially saturated alluvial or bedrock sediments, and an extensive amount of landfill cover material and other disturbed sediments. The large anomaly occurring in the main portion of the landfill is also associated with the area in which the most intensive magnetic anomalies occur and can therefore be attributed in part to buried conductive metallic objects.

Other cultural ~~features~~ delineated by the EM survey include the buried gas pipeline, located along the north boundary of the west half of the area, and the conductivity anomaly that occurs along the east half of the buried outfall line. It is possible that the thickness of the cover material along the west end of the outfall line exceeded the penetration depth of the EM instrument used in this survey (approximately 15 to 20 feet), and that the anomaly associated with the east end of the line is due to either the natural moisture occurring in the fill material around the line, or from a leak along the line. The preliminary maps resulting from the survey also show partial linear anomalies along the SID and partial linear anomalies associated either with an abandoned gas line or the overhead power lines that extend over the south half of the area. These anomalies are not shown on Figure 3.

2.4 MAGNETOMETER SURVEY RESULTS

The purpose of the magnetometer survey performed September through November 1992 was to indicate the locations of subsurface ferrous objects. Because these objects may be buried waste, this information was used to assess the appropriate extent and orientation of the soil gas survey grid.

The extent of the landfilled area is primarily based on magnetic information with some contribution from EM induction results. The initial magnetic data were presented as a total magnetic-field contour map and as a magnetic gradient map. The total magnetic field map probably reflects only the most significant anomalies, whereas the gradient map includes an abundance of anomalies that are probably associated with magnetic metallic trash throughout the area, resulting in a map with an overall cluttered appearance. Using only the total magnetic field data, the most significant anomalies are plotted on Figure 3. The areas of interest include the area to the west associated with landfill bank slump where the metallic U^{238} source was identified, the area of indicated buried metallic objects in the vicinity of the former ponds, indicated buried magnetic objects associated with the main landfill, and the area over the east half of the outfall pipe. The manholes associated with the outfall line were also defined by the magnetic survey. It was again assumed that the depth of the west end of the outfall line exceeded the detection depth of the magnetometer, or that a non-detectable concrete pipe was used between the two manholes.

Useful data could not be acquired beneath the power lines because of the overriding electromagnetic frequency (EMF) produced by the lines. Although it is known that some metallic trash was displaced to the south of the SID during its construction, the anomalies shown on both the initial total magnetic field map and the magnetic gradient map appear to be random, and there is insufficient evidence to assess the reliability of most of these anomalies. Consequently, such anomalies are not depicted on Figure 3.

3.0 SOIL GAS SURVEY PROGRAM

The OU 5 Phase I RFI/RI Work Plan (DOE, 1992) specified that soil gas samples be collected on a 100-foot ~~grid over~~ the Original Landfill and the disturbed area to the east. The grid was to be reduced to 25-foot spacing at the downgradient perimeter of the landfill, over areas of suspected buried metallic materials based on the EM and magnetometer surveys, and over areas where volatiles are found during the 100-foot grid soil gas survey. This 25-foot soil gas grid spacing around the downgradient perimeter was to cover at least the area between the last 100-foot grid location within the landfill area and the first 100-foot grid location outside the landfill area. Furthermore, the 25-foot soil gas grid located over metallic materials or volatile plumes was to continue for at least 50 feet beyond the edge of the anomaly (DOE, 1992).

However, operational data from recent soil gas surveys conducted at Rocky Flats were utilized in conjunction with a transient subsurface pressure distribution equation (Equation I) to assess the radius of influence of this soil gas survey (Johnson, et al., 1990).

$$P' = \frac{Q}{4\pi m(k/\mu)}\left[-0.5772 - \ln\left(\frac{r^2 \varepsilon \mu}{4kP_{atm}}\right) + \ln(t)\right]$$

(Equation I)

where:

P' = "gauge" pressure measured at distance r and time t
m = stratum thickness (3 m)
r = radial distance from vapor extraction well
k = soil permeability to air flow (5.0×10^{-2} to 1.52×10^{-1} darcies)
μ = viscosity of air (1.8×10^{-4} g/cm-s)
ε = air-filled soil void fraction (0.10)
t = time
Q = volumetric vapor flow rate from extraction well (0.70 to 0.97 scfm)
Patm = ambient atmospheric pressure = 1.013×10^{6} g/cm-s^2.

The results of this analysis indicated that a 10-foot radius of influence was achievable under the operating conditions expected at the OU 5 landfill. A more efficient sampling plan is proposed below on this basis.

3.1 PRELIMINARY GRID

The preliminary soil gas survey will encompass the entire landfill area (as determined by the aerial photographs, 1990 gamma radiation survey, and the magnetometer and EM surveys conducted September through November 1992) on a 100-foot grid, as specified in the OU 5 Work Plan (Figure 4). However, review of the photographs and the results of the other surveys and site reconnaissance indicated various surface features that may preclude soil gas sampling at some sites. The site reconnaissance verified the location of an RCA along the western limit of the landfill inside which the collection of soil gas samples would require extensive personal protective equipment and additional health and safety monitoring. It is proposed that soil gas sampling not be conducted inside the boundaries of RCAs. Other surface features that may preclude the collection of soil gas samples include water-saturated areas, rock and trash piles, heavy brush, and very steep slopes.

3.2 SECONDARY GRID

The downgradient perimeter of the landfill is proposed to be surveyed at 40-foot intervals that comprise a three-row, triangular (equilateral) grid (Figure 4). Based on the 10-foot radius of influence, this spacing will provide adequate coverage with respect to vapor flow paths occurring perpendicular to the survey. This mesh of sample locations is intended to detect discrete rivulets of volatile organics at the downgradient landfill perimeter.

In addition, the proposed coverage of magnetic anomalies consists of a 50-foot triangular grid. Magnetic anomalies that are too small to be covered by such a grid will be surveyed with a 25-foot grid. However, the magnetic anomalies occurring along the buried outfall pipe will not be included in the 50-foot or 25-foot grid because these magnetic anomalies have been determined by EG&G to be caused by the outfall pipe, not by buried waste.

The analytical results from the primary-grid and secondary-grid soil gas sampling will be reviewed, mapped, and interpreted in as rapid a manner as possible so that any tertiary samples that are necessary can be taken in a time frame that minimizes potential survey variations. Such variations may ~~include~~ weather, temperature, sampling crew, and sampling devices.

3.3 TERTIARY GRID

The results of the primary and secondary soil gas surveys will be reviewed to assess the locations of soil gas anomalies. It is anticipated that the soil gas survey will result in several locations exhibiting levels of contaminants at or below three times the laboratory detection limit, thereby providing a background level by which to determine anomalous readings. However, if fewer than five sample locations exhibit such low levels of contaminants, additional soil gas samples will be collected from the area bounded by the dirt-road loop just northwest of (and upgradient of) the IHSS 115 boundary. Soil gas concentration anomalies will be defined as those that are greater than three times the laboratory detection limit or greater than three times the observed non-zero background level. Any soil gas anomalies encountered will trigger the collection of additional samples offset by 20 feet. The additional 20-foot samples will extend to the first such sample at which the soil gas concentration is no longer in the anomalous range.

Figure 4 presents the proposed primary and secondary soil gas sampling grids. Currently, the total number of soil gas samples to be collected is 343: 73 samples at 100-foot centers, 96 samples at 50-foot centers, and 174 samples at 40-foot centers. An unknown quantity of tertiary sampling sites at 20-foot centers may be required if soil gas anomalies are detected.

The results of the soil gas survey will be verified by resampling 10 percent of the locations exhibiting anomalous readings and 10 percent of the locations exhibiting readings below three times the laboratory detection limit. The maximum number of repeat samples will be 27, so as not to exceed the 370 samples specified in the OU 5 Work Plan.

Plumes of volatile organics identified by the soil gas survey will be further assessed by the drilling of soil borings within the plumes. As specified by the OU 5 Work Plan, three soil borings will be placed at up to three areas where plumes have been identified. This will result in a maximum of ~~nine~~ soil borings being drilled at the three plume areas. At each plume area, one soil boring will be placed at the point of the highest soil gas reading, and two borings will be located downslope of that point within the plume (DOE, 1992).

3.4 DECONTAMINATION

Decontamination will be in accordance with SOP FO.3 (EG&G, 1992a).

3.5 SAMPLING METHODS

Soil gas sampling methods will be in accordance with SOP GT.9. The soil gas sampling system includes a truck-mounted hydraulic probing apparatus and hollow steel soil probes with gas sampling tips. A manual probing apparatus will also be available for sampling sites that are inaccessible to the truck-mounted system.

Typically, the soil sampling probes will be pushed into the ground using a hydraulic ram system mounted on the back of a pick-up truck. However, in areas where the steep terrain precludes the use of this unit, the sampling probes will be hand driven. The probe is a hollow steel rod with a retractable tip allowing for the soil vapor entry into the rod. This system has the advantages of allowing sampling to depths of 25 feet, and extraction of soil vapor samples from discrete soil intervals without the introduction of surface air into the hole. However, as stated in the RFI/RI Work Plan for OU 5, soil samples for this survey are currently anticipated to be at an approximate depth of 5 feet, depending on field conditions (DOE, 1992). The samples will be recovered with a vacuum gas sampling system connected by vacuum hose directly through the probe to the sampling tip. The sample is to be collected with a gas-tight syringe and injected directly to the gas chromatograph (GC), as described below.

3.6 SAMPLE ANALYSIS

The soil gas samples will be analyzed for 1,1,1-trichloroethane (TCA), dichloromethane, benzene, carbon tetrachlo~~ride~~, ~~te~~trachloroethene (PCE), and trichloroethene (TCE). Analytical peaks of compounds for which the GC is not calibrated will be noted. It will not be possible to analyze for solvent breakdown products such as 1,2-dichloroethane and vinyl chloride with a GC because they co-elute with other compounds. Vinyl chloride co-elutes with freon compounds, and 1,2-dichloroethane co-elutes with methyl ethyl ketone and dibromomethane (DOE, 1992).

3.6.1 Soil Gas Analysis

The mobile analytical facility operates out of an 18-foot trailer. The trailer is equipped with a research-grade GC, a computerized data acquisition system, fume hood and laboratory supplies. Power must be supplied by either a 110 V line power or a generator. A direct connection to an electrical outlet is preferred due to possible power surges common in small generators. It is anticipated that the trailer will be left on-site for the duration of the job.

3.6.2 Analytical Procedures Overview

3.6.2.1 USEPA Level II Quality Control

USEPA Level II Quality Control (QC) will be provided by the soil gas survey subcontractor. Level II QC is defined as field screening/analytical methods that utilize sophisticated analytical instrumentation that may be set up in a mobile analytical facility. Data can be qualitative and quantitative with data quality dependent on calibration standards, laboratory quality control, instrumentation, and experience of the operator. Data from Level II QC may provide the following:

- Identification of soil, water, air and waste locations which have a likelihood of showing contamination through subsequent analyses;
- Real-time data to be used for health and safety considerations during the investigation;
- Qualitative data relative to a primary calibration standard if the contaminants being measured are unknown;
- Tentative identification of contaminants;
- Presence or absence of contamination; and
- Quantitative data if a contaminant is known and the instrument is calibrated for the given analyte.

3.6.2.2 Instrument Overview

The mobile analytical facility features a Hewlett Packard 5890A gas chromatograph with Photoionization Detector/Electron Capture Detector (PID/ECD) systems. Data acquisition will be performed using an Omega II computerized data system. Analyte separation will be performed by a RESTEK Rtx 502.2 (60m x 0.53mm) megabore GC column used in conjunction with temperature programming.

Detection Limits

Analytical results will be presented in units of micrograms per liter (μg/L), the unit of measurement specified in EPA analytical methods references. Conversion to percentage, parts per million (ppm), or parts per billion (ppb) is dependent upon several factors, including the molecular weight of the individual compounds, air temperature, and air pressure. Detection limits for the listed analytes will be in the sub-μg/L range. Detection limits will be a function of detector type, injection volume, and specific analyte response.

Analyte	Detection Limit (μg/L)
Dichloromethane	0.75
Benzene	1.0
1,1,1-Trichloroethane	0.25
Carbon tetrachloride	0.10
Tetrachloroethene (PCE)	0.30
Trichloroethene (TCE)	0.25

Standards and Reagents

Standards are prepared EPA certified calibration standards from NSI Environmental Solutions. All procedures for standard preparation by the soil gas subcontractor are documented in the subcontractor's standards log book. Liquid standards will be prepared by measuring a known volume of standard solution to a class A volumetric flask and then subsequently diluted. Standards will be stored in glass vials with PTFE liners at 4°C.

Instrument Calibration

Gas chromatographic conditions will be established for analyte resolution and quantitation. Analytical calibration standards will be injected by direct injection techniques. All instrument calibration procedures will be performed by external calibration procedures.

Standards will be prepared at a minimum of three concentration levels for each of the analytes of interest by decanting stock solutions into a volumetric flask and diluting with an appropriate solvent. The low standard will be near, but above, the instrument detection limit.

Calibration standards will be 1 to 5 μL. Response Factors (RF) for each analyte will be computed by Equation II. This calculation yields total mass injected in nanograms (ng).

$$\text{Volume Injected } (\mu L) \times \frac{\text{(Concentration } (ng/\mu L)\text{)}}{\text{Area Counts}} \qquad \text{(Equation II)}$$

Analyte linearity will be determined by finding the average RF for each analyte as well and the standard deviation. If the ratio of response to the amount injected (RF) is a constant over the working range (<20% relative standard deviation, RSD) linearity through the origin may be assumed and the average RF can be used in place of a calibration curve. The percent RSD is calculated by Equation III:

$$\frac{\text{(Standard Deviation)}}{\text{Average RF}} \times 100 \qquad \text{(Equation III)}$$

The working calibration curve must be verified by a calibration verification at the start of each working day and after eight hours of instrument run time. If the RF of any parameter varies by more than 20%, corrective action and/or a new calibration curve must be analyzed.

Soil Gas Analysis

Soil gas analysis will be performed by direct injection of a gas sample via a 5.0 cm^3 glass syringe with a sampling valve.

Analyte identification will be made by comparison of standard retention times (RT) to those of the unknown. Daily retention time window studies will be performed to establish the width of the RT window. The daily RT window study will be made by averaging the relative RT of each analyte during instrument calibration and calibration verification during the course of the day. Three times the standard deviation of a compound will be used to establish daily RT windows; however, the experience of the analyst will weigh heavily in the interpretation of sample chromatograms.

Calculations

Soil gas quantitations will be conducted on a mass-per-unit-volume (ng/cm^3) basis, as expressed in Equation IV:

$$\frac{(RF,ng)*(Sample\ Area)}{Volume\ Injected\ (cm^3)} \qquad \text{(Equation IV)}$$

Conversion to µg/L will be made by a conversion as expressed in Equation V:

$$\frac{ng}{cm^3} \cdot \frac{cm^3}{mL} = ng/mL = ug/L \qquad \text{(Equation V)}$$

Quality Control

Analytical quality control protocols are necessary to demonstrate that all procedures used during the analytical process are free of contamination and that instrumental parameters are in accordance with the above specified methodologies.

For the determination of VOCs in soil gas samples from glass syringes, the following procedural mechanisms will be used in the mobile facility to demonstrate that the sampling syringe is free of interferences and contamination:

- Thermal cleaning of each syringe;
- Syringe blank injection performed after thermal cleaning;
- Instrumental calibration, and calibration verifications as specified above;
- One soil gas duplicate analysis for every ten samples; and
- Daily retention time window studies.

Detailed QA/QC procedures are detailed in the soil gas survey subcontractor's laboratory QA/QC manual.

3.7 DATA PACKAGE PREPARATION

Field data will be input into the Rocky Flats Environmental Database System (RFEDS) using a remote data-entry module supplied by EG&G. Data will be entered on a timely basis and a 3.5-inch diskette will be delivered to EG&G. A hard copy report will be generated from the module for contractor use. The data will be put through a prescribed quality control (QC) process to be generated by EG&G based on SOP FO.14 (EG&G, 1992c) (DOE, 1992).

4.0 REFERENCES

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EG&G, 1992b, Environmental Management Department (EMD) Manual Operation Standard Operating Procedure (SOP) FO.3, Revision 2, "General Equipment Decontamination," March 1.

EG&G, 1992c, Environmental Management Department (EMD) Manual Operation Standard Operating Procedure (SOP) FO.14, Revision 2, "Field Data Management," March 1.

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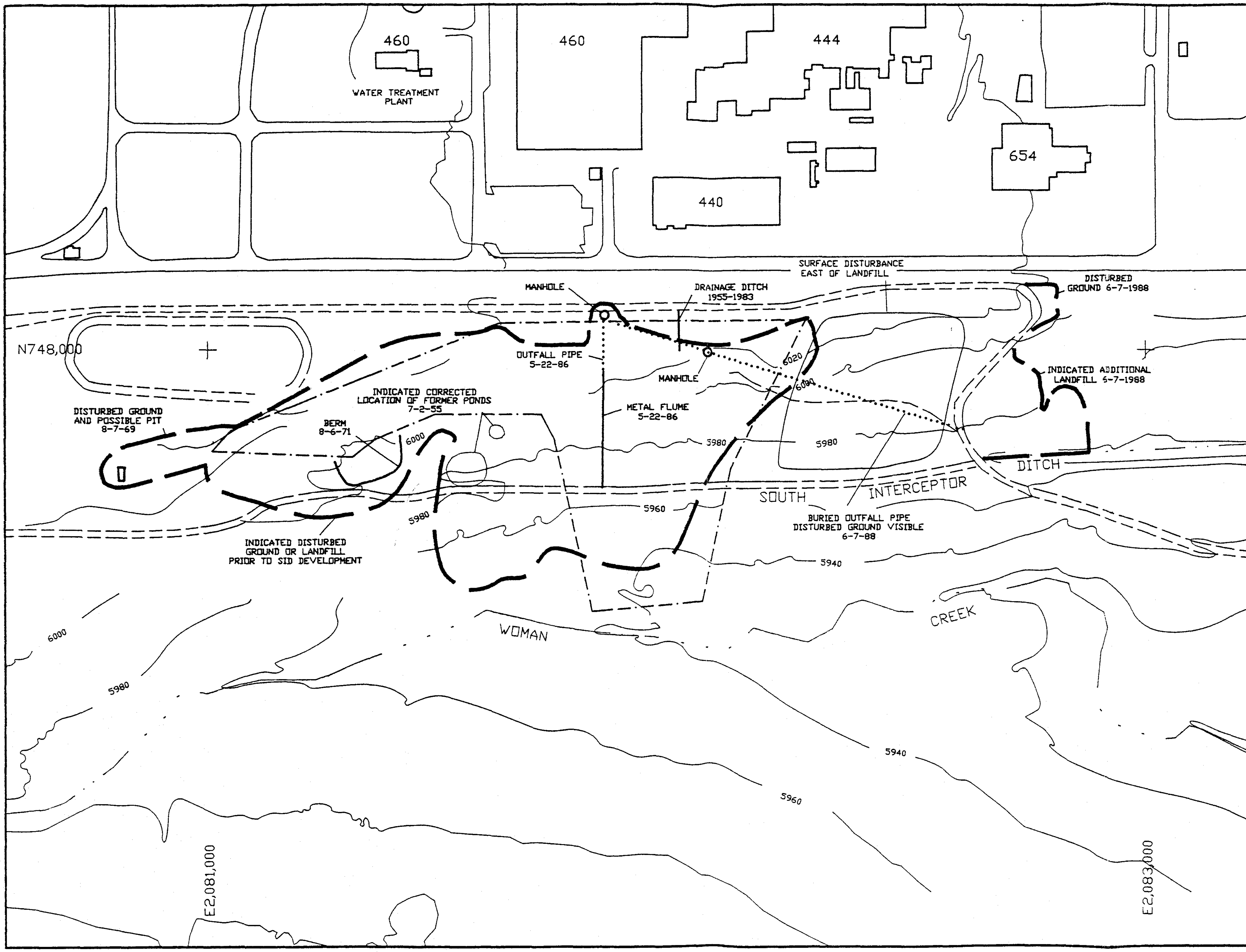
U.S. EPA, 1987, Office of Emergency and Remedial Response and Office of Waste Programs Enforcement, *Data Quality Objectives for Remedial Response Activities, Example Scenario: RI/FS Activities a Site With Contaminated Soils And Ground Water* EPA/540/G-87/004, OSWER Directive 9355.0-7B, March 1.



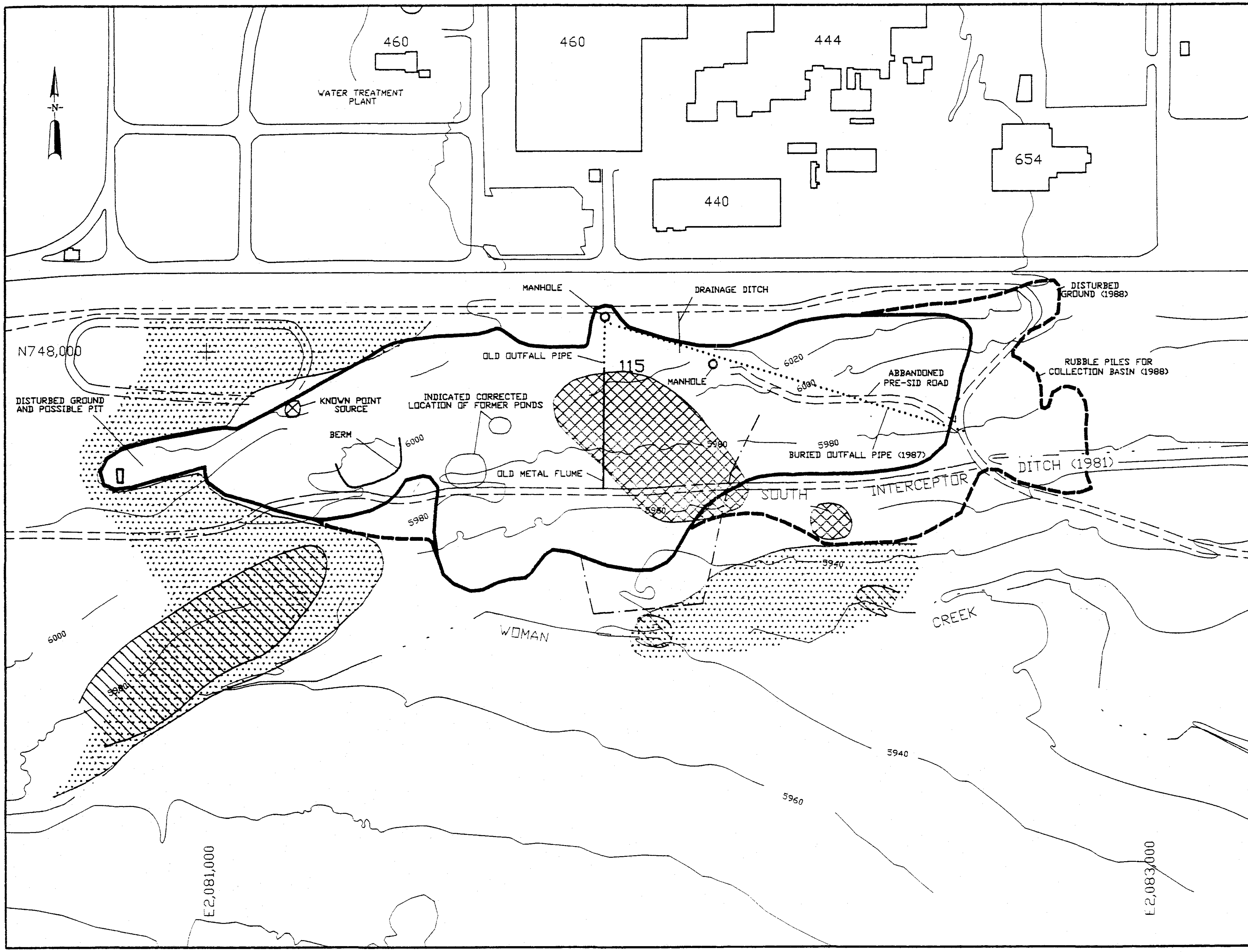
LANDFILL BOUNDARIES

TM5 - LANDFILL (IHSS115) SOIL GAS SURVEY

OU5 PHASE I RFI/RI IMPLEMENTATION

EG&G | 9208.15.01.15 | FEB. 5, 1993 | FIGURE 1

DSTM5 LDWG

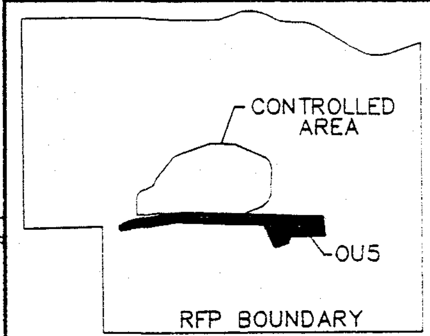


MAP LEGEND

- STREAMS DITCHES DRAINAGE FEATURES
- PAVED ROADS
- DIRT ROADS
- 440 BUILDINGS
- 115 ORIGINAL LANDFILL AND SURFACE DISTURBANCE PRE - SID
- LANDFILL AND DISTURBANCE POST - SID
- EPA/CDH EXTENSION OF LANDFILL BOUNDARY
- INDICATED UNDISTURBED GROUND FROM Cs^{137} DATA
- U^{238} ANOMALY (>4 pCi/g) PROBABLE AIRBORNE PARTICULATE SOURCE
- U^{238} ANOMALY (>4 pCi/g) ASSOCIATED WITH LANDFILL MATERIAL

0 100 200

SCALE: 1" = 200'



SUMMARY OF HPGe SURVEY RESULTS

TM5 - LANDFILL (IHSS115) SOIL GAS SURVEY

OU5 PHASE I RFI/RI IMPLEMENTATION

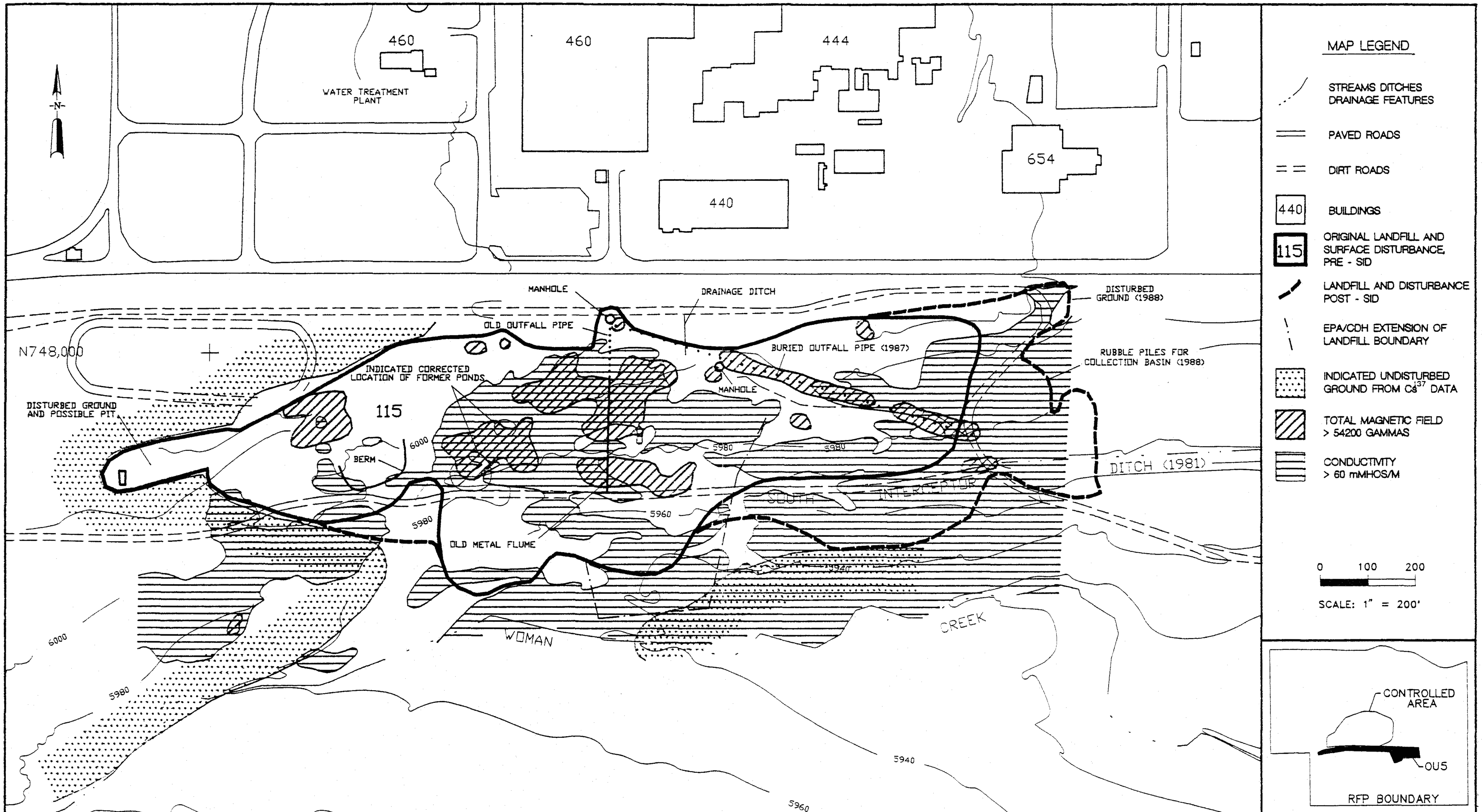
EG&G

9208.15.01.15

FEB. 5, 1993

FIGURE 2

DSTM5-2.DWG



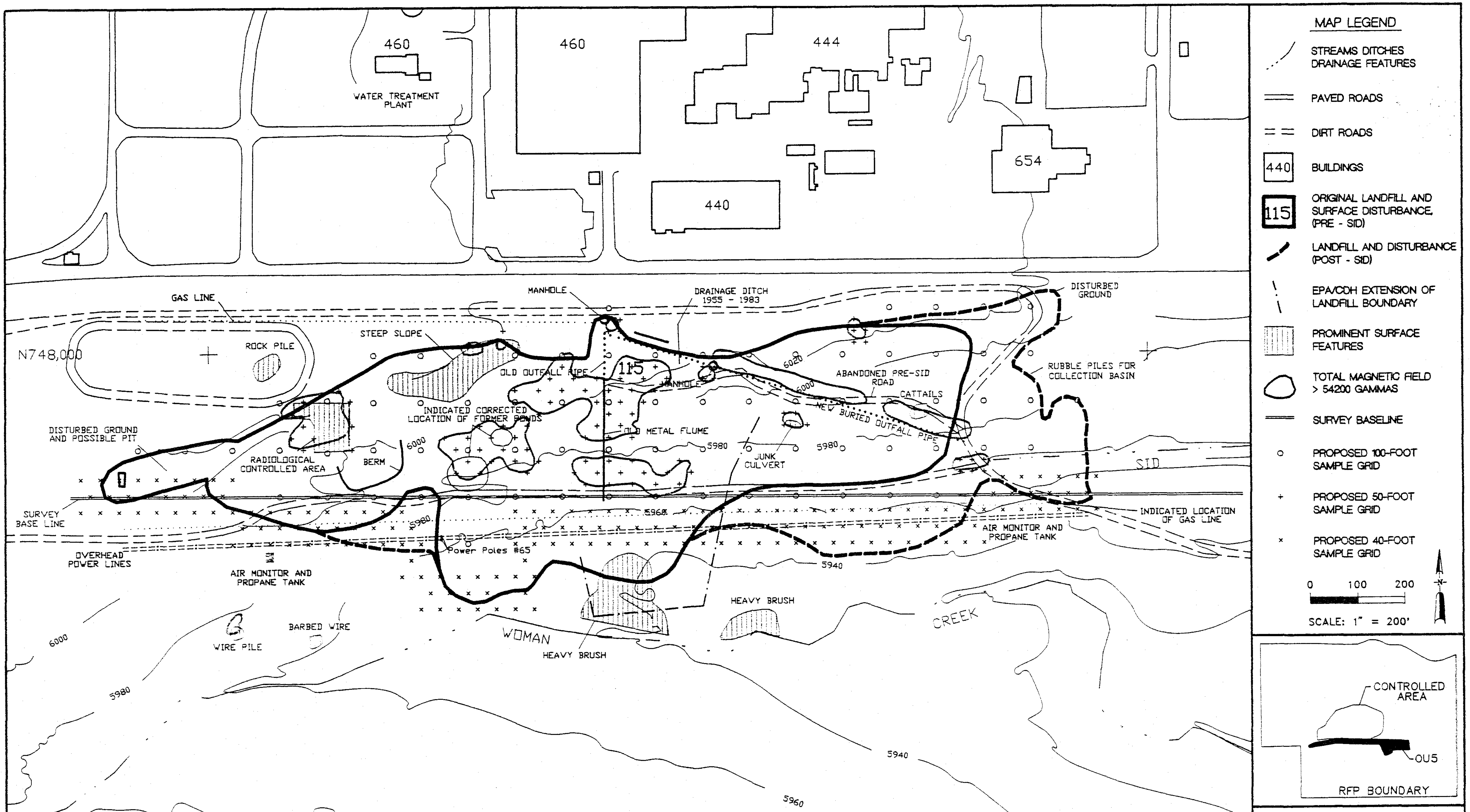
SUMMARY OF ELECTROMAGNETIC AND MAGNETOMETER SURVEY DATA

TM5 - LANDFILL (IHSS115) SOIL GAS SURVEY

OU5 PHASE I RFI/RI IMPLEMENTATION

EG&G | 9208.15.01.15 | FEB. 5, 1993 | FIGURE 3

DSTM5-3.DWG



SURFACE FEATURES AND PROPOSED SAMPLING GRID

TM5 - LANDFILL (IHSS115) SOIL GAS SURVEY

OU5 PHASE I RFI/RI IMPLEMENTATION

EG&G

9208.15.01.15

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FIGURE 4

OSTM5-4A.DWG and OSTM514A.DWG